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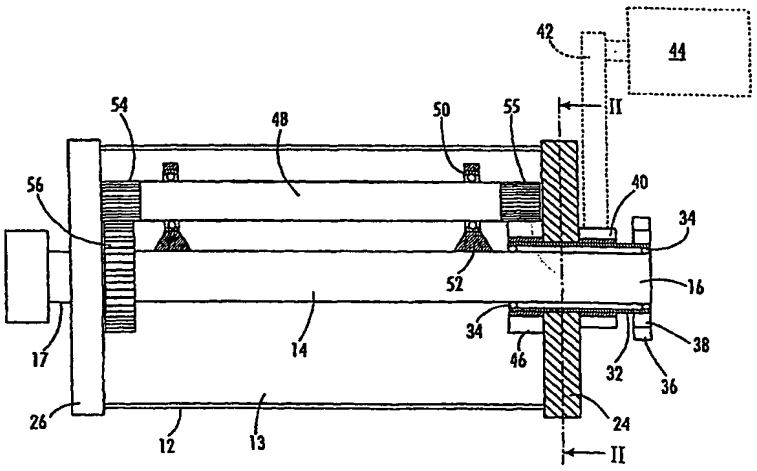
(54) Title: BOARD PRODUCT AND METHOD FOR MAKING THE SAME



(57) Abstract: A coated board product, which has one or more plies of fiber and whose outside plies consist of bleached chemical pulp and middle plies of mechanical pulp and/or broke, and which board has a basis weight of 150-400 g/m^2, said board having a top side and a back side, and manufacturing of the product involves prior to coating the use of one or more surface conditioning devices functioning as a precalender and comprising: a fixed support element, a flexible jacket fitted around the fixed support element, such that a board web travels between the jacket and a counter-roll, a load element provided in connection with the support element, such that the flexible jacket is applied by the load element against the heatable counter-roll, whereby the board web present between the jacket and counter-roll becomes calendered, and the coated product has surface properties on the top side of the board as follows: PPSs10 roughness (ISO 8791-4) 0,5-2,0 µm Hunter gloss (ISO/DIS8254) ~35-80 %, and which product has a density (SCAN-P7:75) within the range of 500-1000 kg/m^3.

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Board product and method for making the same

The invention relates to a coated board product and its production.

An object of the invention is to improve the quality of board products, especially boxboard, and the economy of producing the same.

Board is required to have a certain surface quality for ensuring a desired gloss and print quality, a stiffness and tear resistance for securing the functionality of a package. Since board is produced in large quantities in a board mill, the efficient use of raw material is also important. These demands are somewhat contradictory to each other. Board can be provided with a sufficient gloss by calendering the board by compressing it in a nip, often moistened and heated in a certain manner. The surface fibers and coating of board are preferably pressed smooth by this compression, yet without compacting the middle ply of board. The compaction of a middle ply undermines board stiffness and reduces tear resistance. The compaction of a middle ply is often referred to as a loss of bulk. In this case, bulk is understood as being an inverse value to density and a loss thereof is thus equal to a densifying compaction of paper or board.

Since the process of making paper and board is highly raw material intensive, even a minor saving in raw material provides a major advantage over competitors. In this respect, a saving of just one percent can be considered a major competitive edge and the investment restitution time is short. Saving raw material is also desirable for environmental reasons. By virtue of a reduced weight structure, the multiplicative effects of the board of this invention cover the product's entire life span, the reduced consumption of raw material resulting in a lighter container which ultimately creates savings also in shipping operations and in the way of a reduced amount of waste.

Packing boards are often coated or multiply-structured. Basic board consists typically of three plies of fiber, wherein the top and back plies are made of bleached pulp. The filler ply consists often of mechanical pulp, typically groundwood (GW), but in many cases also pressure groundwood (PGW) and chemithermo-mechanical pulp (CTMP), or the filler ply can also be made by using broke. The face of board is generally coated twice and the back once. Coating and sizing are used for providing desired properties. A typical basis weight range for boxboards is 180-350 g/m^2. The necessary basis weight depends on a required stiffness of the container, a lighter board being sufficient for small boxes. Successful conservation of board bulk in surface treatment to produce thereby board of a higher stiffness results in savings of raw material and energy by enabling the use of board of a lesser basis weight. Typical applications for board include cigarette packages, pharmaceutical packages, postcards, cardboard covers for books, various food packages.

Boxboards are often smoothed with a Yankee cylinder prior to coating, which provides a good bulk and stiffness, the surface properties being also good, the drying shrinkage along the edges being likewise small, yet the use of a Yankee cylinder is limited by speed restraint, space demand for equipment and the enormous size of a Yankee cylinder in a high-speed machine. Another typical treatment method involves a wet-stack calender, the drawbacks of which include problems regarding runnability and a controlled application of water and, in addition, extra costs are incurred by the necessity of drying the board before and after a calendering process.

A machine calender is often used together with other calenders, the machine calender referring to a hard calender with no elasticity in its rolls. The use of a machine calender as the sole surface treatment method is not advisable. A soft calender refers to a soft-nip calender, wherein the calender roll has a

surface which is elastic, the surface having possibly a hardness in the same order as the surface hardness of wood, yet being elastic.

It is an object of this invention to provide a smooth printing surface, a high gloss and stiffness in boxboard with a lesser-than-before consumption of material and to avoid bottlenecks and improve runnability with a method of the invention. This object is accomplished with a packing board as set forth in claim 1. The coated container board of the invention comprises two or more plies of fiber, wherein the outside plies consist of bleached chemical pulp and the inner plies of mechanical pulp or chemithermo-mechanical pulp or broke.

According to the invention, boxboard is treated with a long-nip calender prior to coating or during its coating process in order to upgrade the board qualities over what is known before and, in addition, the production runnability is improved and the production method is not subject to a speed restraint the same way as a Yankee cylinder. A long-nip calender suitable for making a board of the invention has been described for example in the Applicant's patent US6164198.

A calender suitable for the surface treatment of a board of the invention includes a fixed support element, around which is a tubular jacket. A heated counter-element is disposed on the other side of the tubular jacket from the support element, such that a web passes through between said counter-element and the tubular jacket. The fixed support element is provided with load elements, applying the jacket against the heated counter-element and thereby enabling a calendering process between the jacket and the counter-element. The jacket has its opposite ends secured to end walls mounted rotatably relative to the support element, the rotary motion of the end walls being delivered by a separate drive motor, which is independent of a motion of the fibrous web in order to avoid overheating of the jacket.

The design of a long-nip calender suitable for the surface treatment of boxboard of the invention will subsequently be discussed in more detail with reference to the figures.

A method of the invention for conditioning the surface of coated or uncoated board with a surface conditioning device is in turn **characterized** in that the method comprises feeding a fibrous web through a long nip established by a roll and a counter-roll, the former being in the form of a tubular-shaped flexible jacket. Across the extent of the nip the jacket deflects and thereby presses into contact with the counter-roll over a long stretch. The board treated with the method is lighter than currently available boards, while stiffness and surface properties are equal to those of currently available boards.

The solution enables a running speed substantially higher than what is accomplished with a Yankee-cylinder equipped board machine. In addition, the runnability is better, this also contributing to improved quality and reducing waste.

Web speed in the calender may be higher than 600m/min, preferably higher than 800m/min, and still more preferably 1000 m/min, yet lower than 4000 m/min. Thus, the calender does not restrict the speed of a board machine. The above-mentioned heated roll has a temperature of 150-350°C, preferably higher than 170°C, most preferably about 200-250°C. Linear pressure in the nip is within the range of 100-500 kN/m, preferably less than 400, most preferably about 50-300 kN/m. Maximum pressure in the nip is 3-15 MPa, preferably less than 13 MPa, most preferably about 0,5-8 MPa.

Board suitable for the surface treatment of a board of the invention will now be described by means of the figures.

Fig. 1 is a sectional view of a long-nip calender, provided with a long nip between an enclosed shoe calender and a counter-roll.

Fig. 1A is a partial enlargement of fig. 1.

Fig. 2A is a partial sectional view of the device shown in fig. 1, along the roll axis and depicting a drive mechanism.

Fig. 2B shows the operation of press shoes in a longitudinal section.

In fig. 1, a board web 80 travels through an extended and heated nip 1. The nip 1 is established by means of an enclosed shoe roll 10 present under the web 80. Above the web 80 is a heatable counter-roll 22. The enclosed shoe roll 10 comprises a flexible jacket 12 impervious to liquid. The jacket consists for example of fiber-reinforced polyurethane. The stationary fixed support element 14 carries at least one load shoe 18. Between the load shoe 18 and the support element is an actuator 20, such as a hydraulic cylinder, for urging the concave load shoe 18 and thereby also the flexible jacket 12 against the counter-roll 22. Thus, the jacket 12 is forced out of its normal unloaded position 11 in a direction away from the center of the enclosed shoe roll. The jacket 12 is fastened at both ends thereof to end walls 24, 26, thus creating a sealed compartment 13 (see fig. 2). As shown also in fig. 1, at least one detector device 99 is mounted in communication with the web 80 for detecting web breaks. The detector device 99 is connected to a control device 98 for controlling the operation of a calendering process in dependence of the web being broken or not.

As shown in fig. 1, the heatable counter-roll 22 is accompanied by a disengagement mechanism, comprising a lever 95 pivotable by means of a hydraulic cylinder assembly 94 and provided with a pivot point 96 for

pivoting the lever thereon. The disengagement mechanism presses the counter-roll 22 to an engagement with the nip 1 and disengages it from the nip 1.

Between the load shoe 18 and the jacket 12 is supplied a pressurized oil, which develops a hydrostatic pressure throughout the nip and presses the jacket to an engagement with the counter-roll 22 over the entire extent of the nip 1. At the same time, the oil protects the jacket from being damaged by lumps and a temperature rise.

It fig. 2A it is shown that the end walls 24, 26 are rotatably mounted on stub shafts 16, 17 of the support element 14. (The end walls are preferably not integral but divided into a static part and a rotating part as shown in fig. 2B). On one end of the stub shaft, a cylindrical shaft 32 is arranged rotatably via bearings 34. A support column 36 is arranged to the cylindrical shaft via self-aligning bearings 38, which allow spherical movement to allow the deformation/bending of the support element 14 when heavily loaded. One of the end walls 24 is fixedly attached to the cylindrical shaft. A drive transmission 40 is fixedly attached to the cylindrical shaft outside the end wall, in the shown embodiment a cog wheel. The cog wheel is connected to a transmission 42 and in turn a drive 44. A cog wheel 46 is fixedly attached to the cylindrical shaft inside the end wall. A drive shaft 48 is arranged inside the jacket and parallel to the support element 14. The drive shaft 48 is supported by bearings 50 arranged in bearing houses 52 attached to the support element. At each end of the drive shaft, cog wheels 54 are arranged. Preferably these cog wheels have a prolonged toothed portion to allow axial movement of the intermeshing cog wheel which is attached to the end wall. A further cog wheel 56 is fixedly attached to the second end wall 26 inside the jacket. Both cog wheels inside the jacket mesh with the corresponding cog wheel on the drive shaft. The second end wall 26 is rotatably arranged

on the second stub shaft 17. The second stub shaft is in turn fixedly attached to a second support column 58.

The operation is as follows. During normal operation, the driven heated roll 22 is in interaction with the fibrous web and the flexible jacket 12 by means of a desired pressure being exerted by the load shoe 18, thereby causing a friction based drive of both the fibrous web and the flexible jacket. Accordingly, during normal operation the forces exerted in the nip provide for rotation of the enclosed shoe roll.

Only in specific occasions, it will normally be desirable to operate the independent drive of the enclosed shoe roll 10, for example when starting up the calender. If the calender should be started without first speeding up the flexible jacket 12, this would inevitably cause damage to the flexible jacket due to overheating. Furthermore, it would also be deteriorating for the fibrous web, since at the moment of start it would develop exceptional tension forces in the fibrous web. Accordingly, the independent drive arrangement of the enclosed shoe roll is to be used for instance at the start-up of the calendering surface. At the start, the nip gap is not closed, but the roll 22 has been moved out of contact with the nip 1. Before moving the heated counter-roll 22 into the nip, the drive arrangement 44 of the enclosed shoe roll 10 is activated to accelerate the first end wall 24 via transmissions. The rotation of the end wall causes the inner first cog wheel 46 to rotate, and subsequently the drive shaft 48. The drive shaft transmits the rotation to the second end wall 26 via the second inner cog wheel 56. The both end walls are thus accelerated and rotate at the same speed until a desired peripheral speed is obtained, which is normally equal to the speed of the fibrous web. The nip is closed by activating the hydraulic piston 94 to pivot the lever 95 and thereby moving the counter-roll 22 into the nip and subsequently the load shoe 18 is urged against the heated roll 22 by means of its actuators 20. Once the calender functions in the desired manner, the

drive arrangement of the enclosed shoe roll can be deactivated and the press roll driven in a conventional manner by means of friction within the nip 1.

In fig. 2B there is shown an alternative embodiment of the drive arrangement for an enclosed shoe roll. This embodiment uses friction for the transmission of rotational forces.

Fig. 2B also shows a more preferred design of arranging the support element and the end walls. The end walls are divided into an inner part 24A; 26A connected non-rotatably to the support element 14, a rotational part 24B; 26B, and a bearing assembly 24C; 26C therebetween. The support element 14 is at its ends arranged with self-aligning bearings 23, 25 to allow a deflection of the support element 14.

In the figure there is shown a drive 44 having a shaft 19B. On the shaft 19B is mounted a disc 19 having a rubber layer at its peripheral end 19A. The outer ends of the flexible jacket 12 are fixedly attached between an annular ring 15, acting as a replaceable force transmitting device, and the periphery of each end wall. The ring 15 is fixedly attached to the end wall. On the inside of the rotational part 24B, 26B of each end wall there is fixedly attached a cog wheel 46, 56. The drive arrangement 44, 19 is movable in and out of contact with the force transmitting device 15. When it is desired to accelerate the enclosed shoe roll 10, the drive arrangement is moved such that the rubber layer 19A comes into frictional engagement with the force transmitting device 15. The cog wheel 46 and the drive shaft 48 transmit the rotation of the end wall 24 to the other end wall 26 by means of the cog wheels 54, 55 and 56, which at the same time function as a synchronizing device. Hence, both end walls 24, 26 are operated as described in reference to fig. 2A. Fig. 2B further illustrates in a schematic view one preferred functional embodiment of the load shoe 18. As a rule, the load shoe 18 is not

disposed diametrally relative to the drive shaft, but perpendicularly as in fig. 2A.

Tests indicated that, in test batches manufactured by means of a long-nip calender as described above, the board could be provided with a ratio of bulk and smoothness better than in currently available types of board. Thus, according to measurements, the object of the invention is well fulfilled.

Shoe calenders can be driven at notoriously high speeds and, furthermore, by the application of an elevated temperature, e.g. about 250°C, and by taking into account a long dwell time in the calendering zone, the resulting gloss finish will be equal to what is achieved in a slower solution using a Yankee cylinder. In addition, the board is provided with improved bulk. In addition to aspects contributing directly to board quality, the results include savings of production space in a mill, the elimination of a production limiting Yankee cylinder, and the provision of a more manageable, more easily controlled system.

In view of producing board of the invention, it is preferred that surface moistening be provided prior to calendering. However, the inventive board can also be produced without surface moistening.

Conducted tests showed that better surface properties were obtained for board with equal bulk. Test runs were performed on board which was calendered with the above-described long-nip calender without smoothing it with a Yankee cylinder.

Methods measured for the same grade of board

	Precalendering conditions			board properties			
	Temperature °C	Linear pressure kN/m	Added water g/m²	Bulk cm³/g	Bendtsen roughness ml/min	PPS roughness µm	Hunter gloss
Yankee reference	-	-	-	1.83	22	1.4	35
Shoe calender	200	100	4	1,84	41	1,5	33
Shoe calender	200	200	4	1,82	25	1,3	32
Shoe calender	250	100	4	1,82	16	1,2	33
Shoe calender	250	200	4	1,82	17	1,2	32

In the test run, reference board and pilot-calendered board were coated twice in a blade coating station, the total amount of coating being about 24 g/m². The products received no final calendering.

Hence, without affecting bulk, the result showed less roughness and more gloss than what was achieved with the Yankee reference. Based on experience, the interpretation of test results represents a progressive step, regarding for example the quality and production economy of boxboard. Generally pilot tests provide results inferior to those obtained in the ultimate environment, so even on the basis of these preliminary tests, it is possible to draw a conclusion that the method is capable of producing board that is better than before and at the same time more easily and economically producible. In addition, the method is applicable to considerably higher speeds than a Yankee cylinder.

Claims

1. A coated board product, which has two or more fiber plies and whose outside plies consist of bleached chemical pulp and filler plies of mechanical pulp and/or broke, and which board has a basis weight of 150-400 g/m^2, said board having a top side and a back side, the production of said product involving the use of a surface conditioning device functioning as a precalender and comprising:
a fixed support element (14),
a flexible jacket (12) fitted around the fixed support element (14), such that a board web (80) travels between the jacket (12) and a counter-roll (22),
a load element (18, 22) provided in connection with the support element (14), such that the flexible jacket (12) is applied by the load element (18, 22) against the heatable counter-roll (22), the board web (80) present between the jacket (12) and the counter-roll (22) becoming calendered, at least one end wall mounted at the end of the flexible jacket in such a way that the flexible jacket (12) is attached to an end wall (24, 26) and the jacket (12) is rotated along with the end wall (24, 26) by means of a drive mechanism, **characterized** in that manufacturing of the product involves prior to coating the use of one or more surface conditioning devices functioning as a precalender the coated product has surface properties on the top side of the board as follows:

PPSs10 roughness (ISO 8791-4)	0,5-2,0 µm
Hunter gloss (ISO/DIS8254)	~35-80%,

and said product having a density (SCAN-P7:75) within the range of 500-1000 kg/m^3.

2. A product as set forth in claim 1, wherein the middle ply material consists of one or more materials in the following group: groundwood (GW), pressure groundwood (PGW), chemithermo-mechanical pulp (CTMP), and broke.

3. A product as set forth in claim 1-2, **characterized** in that the top side is coated one or more times.

4. A product as set forth in claim 1-3, **characterized** in that the back side is uncoated.

5. A product as set forth in claim 1-3, **characterized** in that the back side is coated at least once.

6. A product as set forth in any of the preceding claims, **characterized** in that the basis weight is within the range of 180-350 g/m^2.

7. A product as set forth in any of claims 1-5, **characterized** in that the basis weight is within the range of 180-300 g/m^2.

8. A product as set forth in any of claims 1-7, **characterized** in that the top side has a Bendtsen roughness (SCAN-P21:67) within the range of 0-50 ml/min.

9. A product as set forth in any of claims 1-7, **characterized** in that the top side has a Bendtsen roughness (SCAN-P21:67) within the range of 0-20 ml/min.

10. A product as set forth in any of claims 1-9, **characterized** in that the top side has a PPSs10 roughness (ISO 87911-4) within the range of 0,8-1,5 µm.

11. A product as set forth in any of claims 1-10, **characterized** in that the top side has a Hunter gloss (ISO/DIS 8254) within the range of 40-65%.

12. A product as set forth in any of the preceding claims, **characterized** in that it has a density (SCAN-P7:75) within the range of 750-1000 kg/m^3.

13. A product as set forth in any of claims 1-12, **characterized** in that the product calendering has also involved the use of a single- or multi-nip machine and/or soft calender.

14. A product as set forth in any of claims 1-13, **characterized** in that its precalendering has involved the use of board surface wetting.

15. A product as set forth in any of claims 1-13, **characterized** in that its precalendering has not involved the use of board surface wetting.

16. A method for making a coated board product, said board product having two or more plies of fiber and having its outside plies consisting of bleached chemical pulp and middle plies of mechanical pulp and/or broke, and said board having a basis weight of 150-400 g/m^2, **characterized** in that in the method a web to be coated is introduced for precalendering into a surface conditioning device, comprising:
a fixed support element (14),
a flexible jacket (12) fitted around the fixed support element (14), such that a board web (80) travels between the jacket (12) and a counter-roll (22),
a load element (18, 22) provided in connection with the support element (14), such that the flexible jacket (12) is applied by the load element (18, 22) against the heatable counter-roll (22), the board web (80) present between the jacket (12) and the counter-roll (22) becoming calendered, at least one end wall of the calendering device mounted on the end of the flexible jacket in such a way that the flexible jacket (12) is attached to an end wall (24, 26) and the jacket (12) is rotated along with the end wall (24,

26) by means of a drive mechanism and the web is precalendered with said surface conditioning device.

17. A method as set forth in claim 15, **characterized** in that the precalendering involves the use of surface wetting.

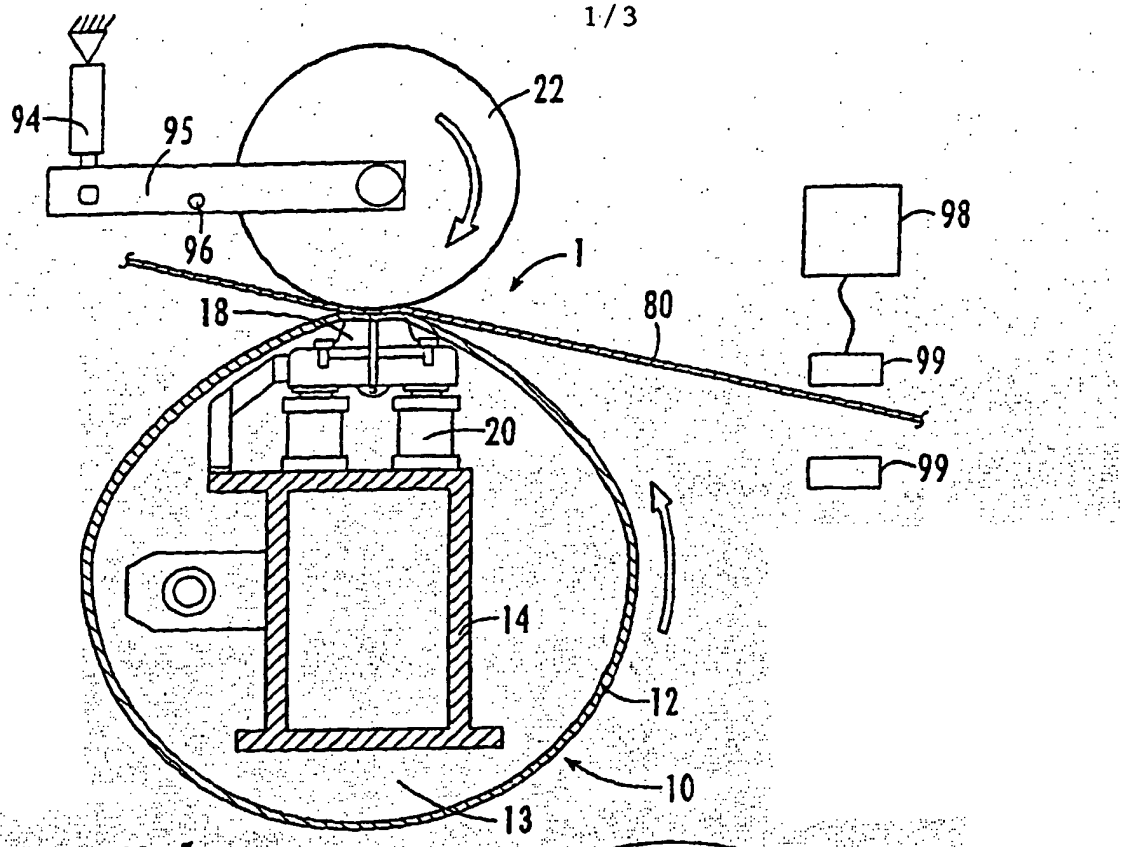

FIG. 1.

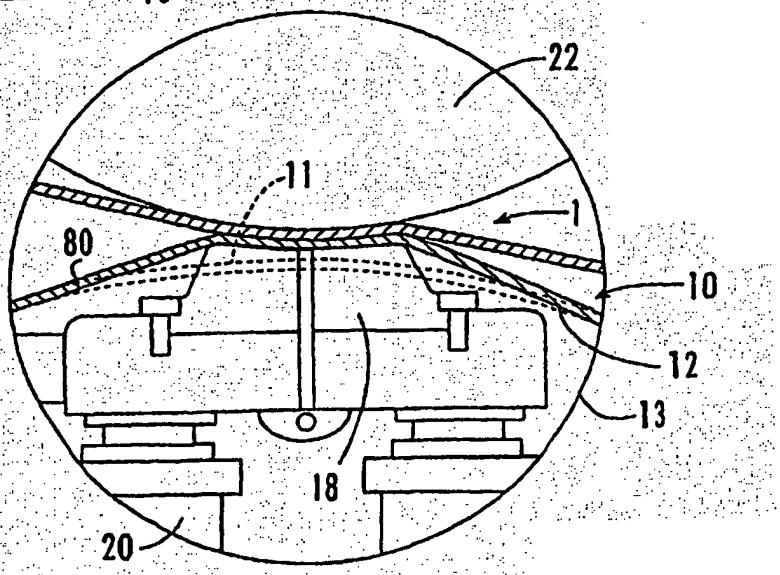

FIG. 1A.

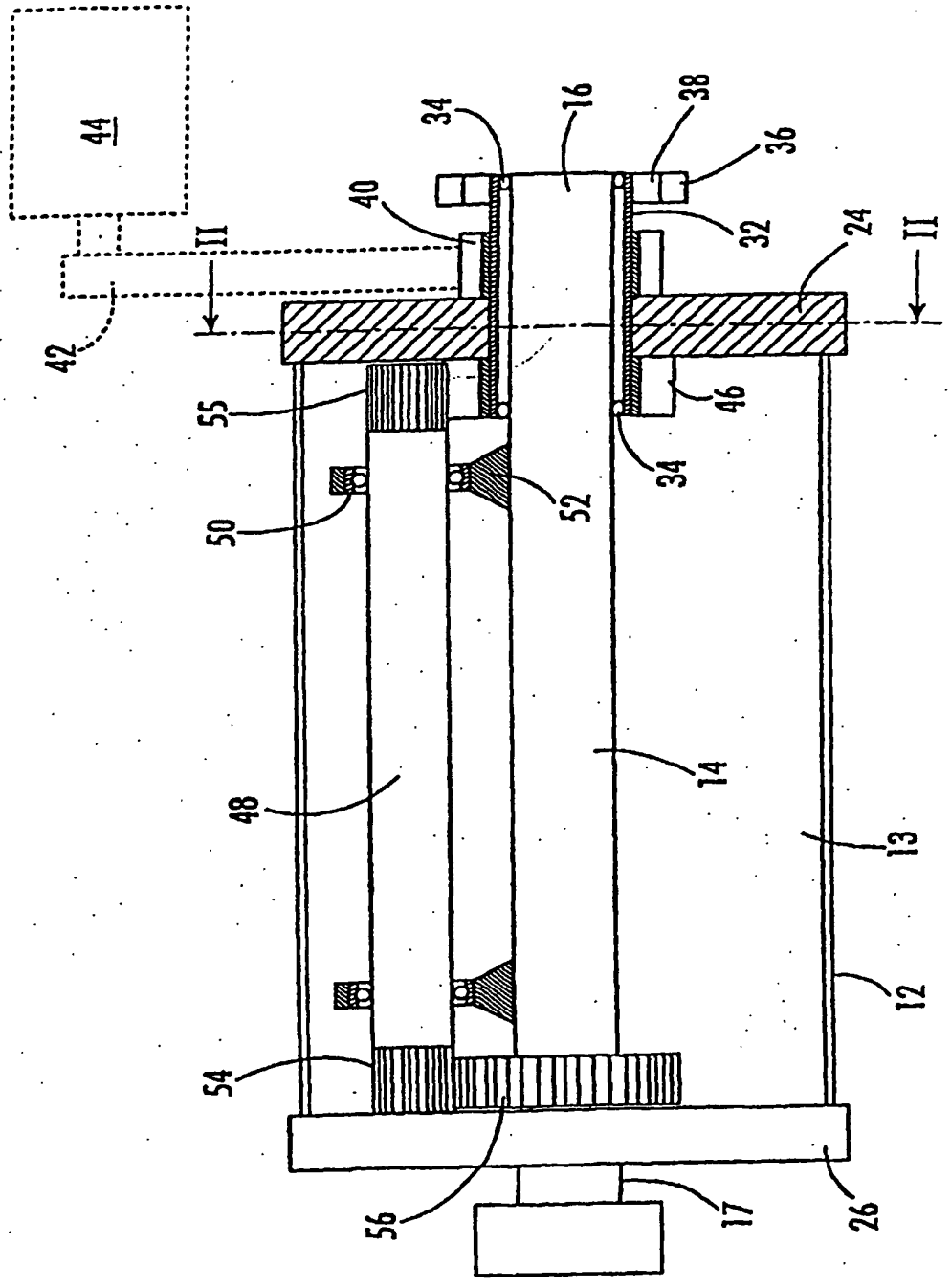

FIG. 2A.

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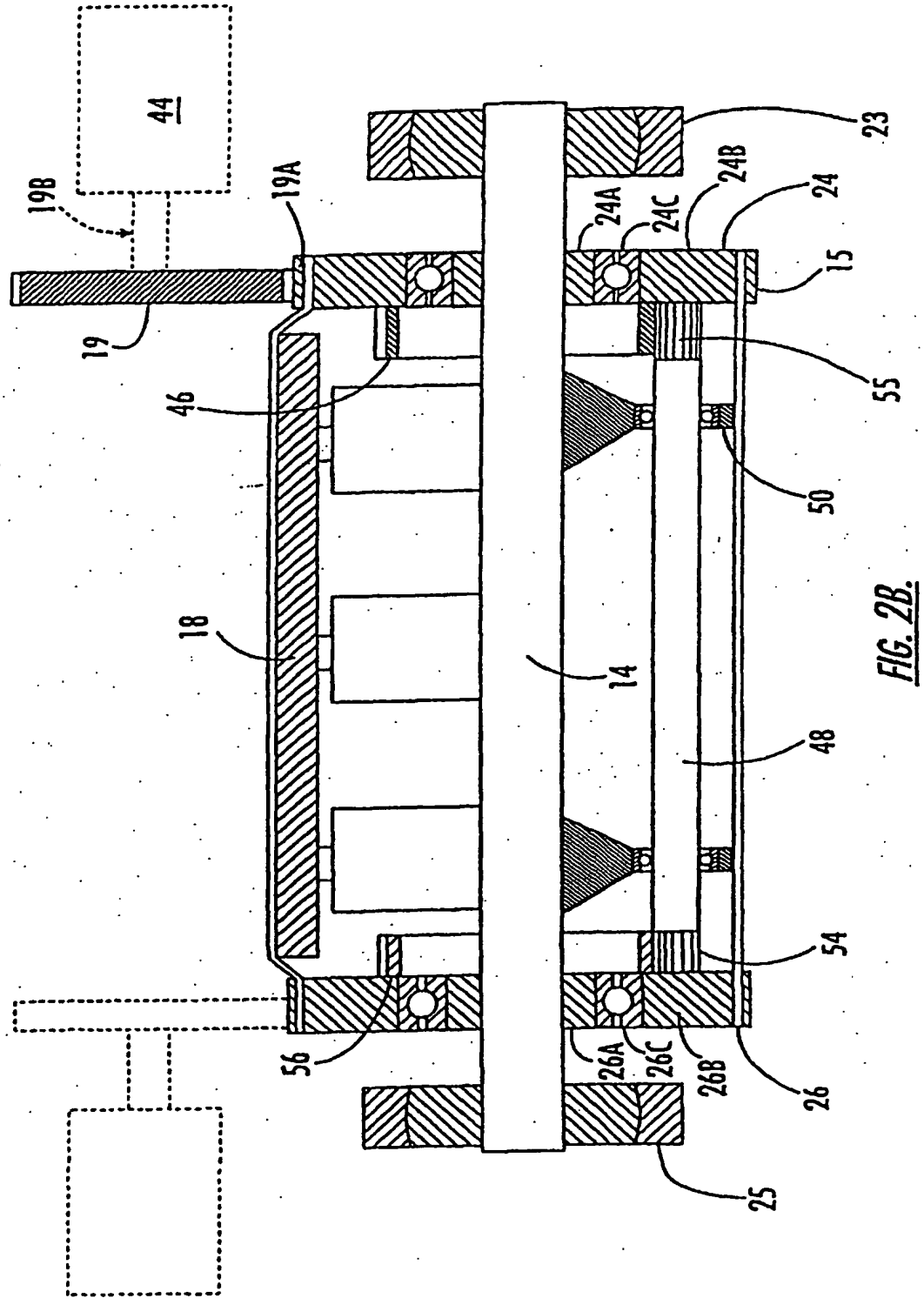

FIG. 2B.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 2003/000871

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: D21G 1/00, D21H 19/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: D21G, D21H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO INTERNAL, WPI DATA

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6164198 A (PETTER HONKALAMPI ET AL), 26 December 2000 (26.12.2000), figures 1,2A, abstract --	1-17
Y	WO 9967462 A1 (VALMET CORPORATION), 29 December 1999 (29.12.1999), page 5, line 32 - page 6, line 7; page 7, line 3 - line 10, abstract --	1-17
A	US 6022448 A (GÖRAN ERIKSSON ET AL), 8 February 2000 (08.02.2000), column 3, line 8 - line 35, abstract, Example 1 --	1-17

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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Date of the actual completion of the international search	Date of mailing of the international search report
13 February 2004	17 -02- 2004
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Nina Bergström/Els Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (January 2004)

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